The Shrimp *Leptalpheus forceps* in Old Tampa Bay, Florida

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The alpheid shrimp, *Leptalpheus forceps* Williams, was collected in Old Tampa Bay, Florida, during studies of benthic invertebrates. This marked the first collection of the species outside the type locality, Beaufort, North Carolina. It was reported there by Williams (1965) as a commensal in burrows of the macruran crustacean, *Upogebia affinis.* The purpose of this report is to document occurrence of the shrimp in Old Tampa Bay, describe the collection site, and record certain ecological conditions in the habitat. These features include sediment type and hydrology within the burrows and from surrounding water. Abundance, size, and reproductive state are also recorded.

Collection Site

Specimens of *Leptalpheus forceps* were collected from exposed intertidal burrows of *Upogebia affinis* in the northeastern section of Old Tampa Bay adjacent to the town of Oldsmar (Fig. 1). In that area of the bay there is a broad, unvegetated, sandy beach at low tide, and large numbers of *U. affinis* occur in a narrow zone near the level of mean low water. A hole in the sediment marks the burrow of the animal (Fig. 2).

The shore adjoining the beach is undeveloped except for a fishing pier extending into the bay about 50 m south of the collection site. Small oyster bars are present on the tidal flats, and cord grass, *Spartina* sp., grows along the edge of the bay.

Procedure

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Bottom material containing burrows of *Upogebia affinis* was dug with a shovel and washed on a fine sieve (Tyler, #24 screen, 0.701 mm mesh). The material was removed to a depth of 1/2 m and within an area of 1/9 m^2 marked by a wooden frame. The frame was placed randomly in areas having a large number of burrow

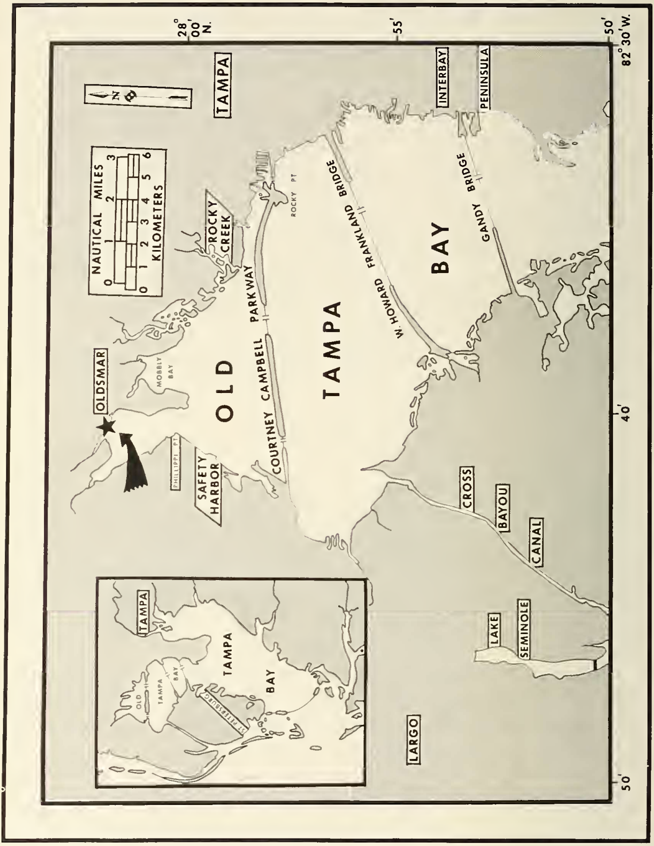

Fig. 1. Collection site (star) for *L. forceps* in Old Tampa Bay, Florida, 1967-1968.

openings. *L. forceps* and its host were picked off the sieve and fixed in 10 per cent sea-water formalin. For permanent preservation, specimens were stored in 70 per cent isopropanol.

Sediment was sampled within each quadrate with a corer (Tay-

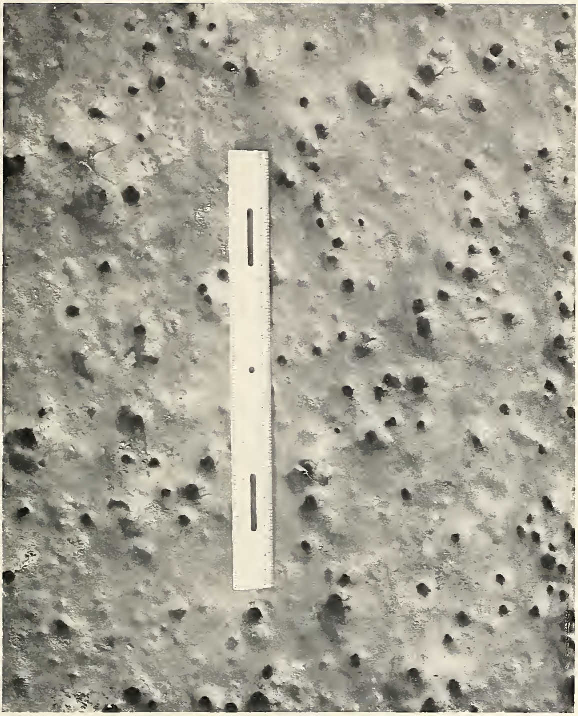

Fig. 2. Burrow openings of *U. affinis* on the beach near Oldsmar, Florida, in upper Old Tampa Bay, 1967-1968. Ruler is one foot long.

lor, 1965). The sediment core was sectioned at 5-cm intervals from the surface to a depth of about 25 cm. No obvious stratification of particle sizes was observed in the sediment cores. Analysis for total sediment texture was made according to methods described by Taylor and Saloman (1969).

Water was sampled concurrently in exposed burrows and in the bay nearby. Water from burrows was removed by mouth suction through a polyethylene tube fitted with a tapered glass tip for insertion in burrow openings. Hydrological factors compared between water from burrows and the bay included temperature, salinity, *p*H, total Kjeldahl nitrogen, total phosphorus, and dissolved oxygen. In addition to these features, analysis of bay water also included turbidity. Average hydrological conditions for upper Old Tampa Bay and methods of water analysis were reported by Saloman, Finucane, and Kelly (1964); Saloman and Taylor (1968); and Saloman and Taylor (in press).

Observations on the biology of *L. forceps* included abundance, carapace length, reproductive state, and number of eggs per female. Carapace length was determined with an ocular micrometer by measuring from the posterodorsal margin to the anterodorsal margin that covers the eye. Reproductive stages were noted, and eggs on each gravid female were removed from the abdomen and counted.

SEDIMENT

Burrows of *Upogebia affinis* were dug in sediment that had an average composition of 95.3 per cent silicious sand, 1.3 per cent silt, and 3.4 per cent clay. Only a small fraction of the sand size sediment particles consisted of carbonate material. Other analyses from upper Old Tampa Bay north of Phillippi Point showed that the average weight percentage of silicious sand, silt, and clay was 91, 5, and 4, respectively (Taylor and Saloman, 1969). Statistical data from these studies show that sediment sorting is poor (1.319 Ø) and indicate that there is little uniformity in the particle size of the sand fraction (Folk, 1964).

HYDROLOGICAL CONDITIONS

Average hydrological conditions recorded near the collection

TABLE 1

Hydrographic observations for 1967-1968 from the collection site for *L. forceps* in Old Tampa Bay, Florida*

Month	Year	Water temp. C	Salinity ppt	*p*H	Total phosphorus μg at./1	Total Kjedahl nitrogen μg at./1	Dissolved oxygen ml/1	Jackson Turbidity units
January	1967	22.0	24.11	8.01	24.8	50.7	4.83	6.0
	1968	20.7	25.44	7.63	26.2	53.6	4.59	19.5
February	1967	16.5	24.83	8.08	29.9	33.3	4.83	1.4
	1968	18.1	27.05	7.92	9.2	2.1	3.70	2.3
March	1967	16.2	24.96	8.04	18.0	57.3	4.91	4.9
	1968	14.7	28.39	8.13	22.9	5.7	4.91	1.7
April	1967	22.4	26.64	7.79	23.6	49.3	4.43	12.0
	1968	23.7	29.22	8.11	30.3	40.0	4.11	2.2
May	1967	22.8	28.35	7.95	23.3	68.0	4.27	5.9
	1968	22.8	30.34	7.81	29.5	47.1	3.54	9.3
June	1967	29.1	29.43	7.83	23.2	53.4	3.06	5.5
	1968	26.5	30.46	7.79	24.1	54.3	2.58	6.0

*Data on file at the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida 33706.

TABLE 1 (Cont.)

Hydrographic observations for 1967-1968 from the collection site for *L. forceps* in Old Tampa Bay, Florida*

Month	Year	Water temp. C	Salinity ppt	*pH*	Total phosphorus μg at./l	Total Kjedahl nitrogen μg at./l	Dissolved oxygen ml/l	Jackson Turbidity units
July	1967	29.5	29.61	7.80	21.0	54.3	2.98	3.5
	1968	28.8	27.05	7.76	16.4	62.8	2.58	3.0
August	1967	28.6	27.66	7.67	25.2	42.3	2.58	4.9
	1968	31.0	23.93	7.98	26.8	67.8	1.46	8.7
September	1967	27.9	22.90	7.48	27.8	50.8	2.50	8.9
	1968	28.5	20.95	7.70	30.7	42.8	2.10	4.5
October	1967	24.4	24.07	7.99	28.4	28.6	3.87	21.0
	1968	25.7	20.14	7.73	31.6	46.4	1.70	7.5
November	1967	24.0	24.07	7.75	26.1	54.3	3.87	53.0
	1968	22.7	20.10	7.78	—	71.4	3.14	29.0
December	1967	17.2	25.44	7.78	26.8	35.7	3.78	5.2
	1968	22.6	20.37	7.88	29.1	25.7	4.67	27.0
Average	1967	23.4	26.01	7.85	24.5	48.2	3.83	11.0
	1968	23.8	25.29	7.85	25.2	43.3	3.26	10.1
Average		23.6	25.65	7.85	24.8	45.7	3.54	10.5

*Data on file at the Bureau of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida 33706.

TABLE 2

Hydrographic data from burrows of *U. affinis* and the commensal shrimp *L. forceps* in Old Tampa Bay, Florida, 1967-1968

Date	Temp. C	Salinity ppt	*p*H	Total Kjeldahl nitrogen μg at./l	Total phosphorus μg at./l	Dissolved oxygen Ml/l
1967						
10-28	24.2	23.73	7.49	33.6	31.1	
11-3	25.6	23.19	7.30	117.1	35.2	0.65
						0.06
11-19	20.0	25.48	7.42	30.7	26.1	1.10
		25.26				1.21
12-23	20.0	26.15	7.20	42.8	30.7	0.36
		25.81	7.14	14.3	25.1	0.32
12-31	15.7		7.79	98.6	25.1	
1968						
1-16*	15.0	26.29	7.52	72.1		3.78
						2.60
†	15.5	26.65	7.42	62.1	30.4	1.42
						0.84
1-28	17.5	27.12	7.40	95.0	26.1	2.36
		27.12	7.44	110.7	28.3	0.84
2-17	17.0	27.30	7.66	124.3	31.4	
		27.39	7.77	121.4	24.0	
3-2	12.0	28.31	7.79	123.6	28.9	
		28.55	7.79	53.6	26.2	
3-16	18.8	27.63	7.67	104.3	34.2	
		28.24	7.88	37.8	34.2	
3-28	19.8					
4-13	22.7	29.60	7.51	160.0	32.4	
Average	18.8	26.70	7.54	82.5	29.3	1.29

*0930 sampling time
†1100 sampling time

site show that upper Old Tampa Bay north of Phillippi Point is a moderately turbid and nutrient-rich body of warm, brackish water (Table 1). Heavy concentrations of total phosphorus and total Kjeldahl nitrogen are mainly a result of domestic sewage which enters Old Tampa Bay north of Courtney Campbell Parkway. The sewage originates from eight treatment plants which have a combined design capacity of 1.2 million gallons per day (unpublished data, Gulf of mexico Estuarine Inventory Project, on file at Bureau

TABLE 3

Hydrographic data from surface water collected concurrently with hydrographic data from burrows of *U. affinis* and *L. forceps* in Old Tampa Bay, Florida, 1967-1968

Date	Temp. C	Salinity ppt	*p*H	Total Kjeldahl nitrogen μg at./l	Total phosphorus μg at./l	Dissolved oxygen Ml/l
1967						
10-28	22.7	24.52	7.92	51.4	29.0	
11-3	23.5	23.13	7.53	85.7	27.1	3.62
						3.70
11-19	21.2	24.90	8.05	21.4	25.3	3.35
12-23	21.2	25.26	7.93	61.4	25.1	5.31
						4.36
12-31	14.9	16.63	8.00	60.7	25.1	
1968						
1-16*	13.2	26.46	7.71	42.8	27.1	4.95
						5.19
†	14.5	26.33	8.20	45.7		5.54
1-28						6.25
	19.3	27.12	8.11	44.3	28.3	6.36
2-17						6.48
	15.8	27.48	7.83	45.7	29.1	
3-2						
	12.2	28.21	7.84	17.8	23.6	
3-16						
	20.2	28.78	7.83	44.3	30.3	
3-28		30.77				
4-13	20.8	29.45	7.65	43.6	28.9	
	23.7	26.81	7.87	40.7	26.8	
			7.96	42.1	28.6	
Average	18.7		7.90	46.8	27.0	4.88

*0930 sampling time
†1100 sampling time

of Commercial Fisheries Biological Laboratory, St. Petersburg Beach, Florida 33706). Water circulation in the bay is poor, and nutrients introduced by sewage and land drainage are mostly retained in a cycle of organic production and decomposition as outlined for similar estuarine systems by Duke and Rice (1967). As an annual average, gross primary production by phytoplankton in Old Tampa Bay is 1.23 and 1.22 kcal/m^2/day for 1965 and 1966, respectively (Saloman and Taylor, 1968).

Comparison of water in exposed burrows of *U. affinis* and nearby surface water showed marked differences in *p*H, total Kjeldahl nitrogen, total phosphorus, and dissolved oxygen (Tables 2 and 3). These differences show that biological processes of occupants in the burrow cause an appreciable change in water chemistry during low tide. The two factors that fluctuated mostly were total Kjeldahl nitrogen and dissolved oxygen. In comparison to surface water in the bay, the water in burrows increased in total Kjeldahl nitrogen and decreased in dissolved oxygen by an average of 35.7 μg at./1 and 3.59 ml/1, respectively (Tables 2 and 3).

The degree to which *U. affinis* and *L. forceps* are adapted to these changes apparently sets limits on the shoreward location of burrows. At Oldsmar, most burrows are near the level of mean low tide where they are exposed for no more than a few hours at each ebb tide. Some are at higher levels on the beach, however, and burrows also occur offshore to an undetermined distance.

ABUNDANCE

The greatest number of *L. forceps* collected from a single sample of 1/9 ^{2} was 6. This sample also contained 13 specimens of *U. affinis* and 32 burrow holes. From 7 samples of 1/9 m^2, the mean number of *L. forceps* was 3.3 and the average numbers of *U. affinis* and burrow holes were 20 and 37.9, respectively (Table 4).

TABLE 4

Number of *L. forceps* relative to numbers of *U. affinis,* and burrow holes in samples from an area 1/9 m^2 by 1/2 m deep

Number burrow holes of *U. affinis*	Number *U. affinis*	Number *L. forceps*
18	4	1
25	9	2
31	17	2
32	13	6
50	26	2
50	48	5
59	23	5
—	—	—
Average 37.9	20.0	3.3

TABLE 5

Carapace length, reproductive state, and number of eggs per female for specimens of *L. forceps* from Old Tampa Bay, Florida, 1967-1968

Date	No. of specimens	Carapace length mm	Reproductive state			No. of eggs
				Gravid		
			Nongravid	Noneyed	Eyed	
1967						
9-10	2	3.8-5.3		1	1	70-89
10-8	1	4.1	1			
10-21	2	3.6-5.0	1		1	73
11-19	2	4.3-4.8	2			
12-16	1	5.2	1			
12-31	2	3.9-6.0	2			
1968						
1-16	5	4.9-6.7	5			
2-17	3	6.0-6.2	3			
3-2	5	3.9-5.3	5			
3-16	9	3.8-6.6	9			
3-28	6	4.2-7.6	6			
4-13	1	6.3			1	103
4-27	3	5.7-7.1	1	1	1	140
5-11	3	3.4-6.6	2		1	48
5-25	3	5.3-6.9	2	1		107
6-15	3	6.4-6.9		2	1	226-258
7-12	3	6.4-6.7		1	2	116-178

CARAPACE LENGTH AND REPRODUCTIVE BIOLOGY

Carapace length ranged from 3.4-7.6 mm. The larger figure is nearly equal to that recorded for the holotype (female) described by Williams (1965). Specimens were collected in 11 consecutive months, but probably for several reasons no definite pattern of growth was observed (Table 5). The small number of individuals collected per month made growth calculations by mean size or size frequency distribution difficult. *L. forceps* has an extended spawning period (April-October), and this allows juveniles to enter burrows in all seasons except winter. Furthermore, the sampling failed to yield any postlarval or early juvenile individuals. The smallest shrimp had a carapace length of 3.4 mm, which is only 0.4 mm less than the length of one individual that was gravid (Table 5).

Gravid females had a carapace length ranging from 3.8-7.1 mm. Numbers of eggs increased with size of females, and the number per individual ranged from 48-258 (Table 5). Counts were approximate because some eggs were lost in handling. More eggs per individual were found on specimens collected in June than in any other month. Eggs in the eyed condition were observed on animals collected in September, October, April, May, June, and July. As noted by Manning (*in* Williams, 1965) the living eggs of *L. forceps* were transparent, but became green when preserved in formalin.

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